APPRAISAL ON STRENGTH ARMORED REAL BY FRACTIONAL EXTRA OF FINE TOTAL WITH COPPER SLAG

[1]Name of 1st Mr Kartik Patel
[1]Designation of 1st Assistant Professor
[1]Name of Department of 1st Faculty of Engineering
[1]Name of organization of 1st Gokul Global University, Sidhpur, Patan, Gujarat – India

Abstract - This work aims at the study of strength and durability variations observed by the incorporation of copper slag as partial replacement of sand in glass fiber reinforced concrete and then compared with the strength & durability properties of conventional concrete. All mixes, the proportion of glass fiber is kept constant i.e., 0.5% by volume of concrete.

Keywords-FRC, Copper slag, Fine Aggregate, Coarse Aggregate, Glass fiber aggregate

INTRODUCTION

Utilization of industrial soil wasteor secondary materials has encouraged in construction field for the production of cement and concrete because it contributes reducing the consumption of natural resources. For many years, by-products such as fly ash, silica fume and slag were considered as waste material. They have been successfully used in the construction industry for partially or fully replacement for fine and coarse aggregates. sand present in the cementitious mixes.

It is now recognized that the strength of concrete alone is not sufficient, the degree of harshness of the environmental condition to which concrete is exposed over its entire life is also equally important. Since copper slag contains morethan50% of ferrous content, corrosion and durability factors are necessary to find out, when it is replaced with sand and cement in concrete. Aggregate is the main constituent of concrete, occupying more than 70% of the concrete matrix. Copper slag (CS), the glassy material, produced during mattes melting and copper conversion was previously considered waste and disposed as landfill. Slags containing < 0.8% copper are either discarded as waste or sold cheaply. Processed, air-cooled, and granulated CS has a number of favourable mechanical properties for aggregate use, including excellent soundness characteristics and good abrasion resistance.

Brindhaetal. (2010)studied the presence of silica in slag is about 26% which is desirable since it is one of the constituents the natural fine aggregate used in normal concreting operations.

Mahmoud Amerietal.

Compressive strength tests were performed on samples containing slag ratios of 0, 25, 50, 75 and 100% and cement contents of concrete 200, 300 and 350kg/m3. According to the results, compressive strength improved with the increase in steel slag ratio up to25% and further decreases the compressive strength when increasing the steel slag ratio above 25%.

Suresh Reddy etal. (2013) studied the concrete made of copper slag replacing sand up to 50% are used to study the strength parameters, compressive strength, split tensile strength and flexural strength of both M30 and M40 grade of concrete mixes. Sand was replaced with copper slag in proportions of 0%, 10%, 20%, 30%, 40% and 50%. From the results, it was concluded that the compressive strength, split tensile strength and flexural strength of concrete mix increased marginally up to 40% replacement of sand by copper.

R. R. Chavan & D.B. Kulkarni (2013) studied the concrete made of M25 grade concrete was used and tests were conducted for various proportions of copper slag replacement with sand of 0 to 100% in concrete. The obtained results were compared with those of control concrete made with ordinary Portland cement and sand shows that the maximum compressive strength of concrete increased by 55% at 40% replacement of fine aggregate by copperslag, and up to 75% replacement, concrete gain more strength than control mix concrete strength. Itis observed that, the flexural strength of concrete at 28 days is higher than design mix (Without replacement) for 20% replacement of fine aggregate by copper slag, the flexural strength of concrete is increased by 14%. Compressive strength and flexural strength are increased due to high toughness of copper slag.

Byung Sik Chunetal (2005) studied the strength of composite ground was compared and analyzed by monitoring the stress and ground settlement of clay, sand compaction pile and copper slag compaction pile.

Ke Ru Wuetal(2001) they revealed that if we select high strength aggregate with low brittleness then manufacturing of high strength concrete with lower brittleness can be made.

Mosafa Khanzadi and Ali Behnood (2009) study revealed the effects of replacing limestone coarse aggregate by copper slag coarse aggregate on the compressive strength, splitting tensile strength and rebound hammer values of high-strength concretes are evaluated in this work. Use of copper slag aggregate showed an increase of about 10 –15% compressive strength and an increase of 10–18% splitting tensile strength when compared to limestone aggregate indicating that.
The objectives of the present study are.

1. To study the strength characteristics such as compressive strength, split tensile strength and flexural strength were investigatedwith different proportions.

The scope of the report is to find out the optimum value of replacement of copper slag with constant quantity of Glass fiber with fine aggregate by studying strength properties of FRC concrete.

EXPERIMENTAL INVESTIGATION

Materials Used

'ZUARI' (brand name) 53gradeOPCconformingtoBIS:12269-1987 cement was used. River sand conforming to IS:383-1963 was used to making the concrete mixture. The properties of fine aggregate and coarse aggregate shown in Table. Water confirming to the requirements of BIS: 456-2000 is found to be suitable for making FRC. For this present investigation, drinking water supplied to Coimbatore city from Servant dam was used for making FRC and curing.

PROPERTIES OF FINE AND COARSE AGGREGATE

Property	Fine Aggregate	Coarse Aggregate
Specific gravity	2.417	2.844
Water absorption	0.402	0.251
Grading zone	2	-

PROPERTIES OF GLASS FIBER

Property	Values
Tensile Strength	4890 MPa
Compressive Strength	1600 MPa
Density	2.46

The copper slag used is a black glassy and granular in nature and has a similar particle size range like sand. The specific gravity of slag lies between 3.4 and 3.98.The pH of aqueous solution of aqueous extract as per IS 11127 varies from 6.6 to 7.2.The free moisture content present in slag was found to be less than0.5%.Tests to determine specific gravity and water absorption for copper slag and sand were carried out in accordance with ASTM C128. The results are presented in Table. It is found out that the copper slag has a specific gravity of 3.91 which is higher than that for sand (2.57) and OPC (3.12) which may result in .The measured water absorption for copper slag was 0.16% compared with 1.25% for sand. Therefore, it is expected that the free water content in concrete matrix will increase as the copper slag content increases which consequently will lead to increase in the workability of the concrete.

Physical Properties	Copper slag
Particle shape	Irregular
Appearance	Black &glassy
Type	Air cooled
Specific gravity	3.91
Percentage of voids	43.20%
Bulk density	2.08g/cc
Fineness modulus of copper slag	3.47
Angle of internal friction	51°20’
Hardness	6-7mohs
Water absorption	0.3to0.4%
Moisture content	0.1%
Fineness of copper slag	125m^2/kg

PHYSICAL PROPERTIES OF COPPER SLAG

Design Stipulation for M30 Grade Concrete

2. Maximum size of aggregate= 20mm 3. Degree of quality control= Good 4. Type of exposure= Moderate 5. Cement used Ordinary Portland Cement of 53 grade 6. Specific gravity of cement= 3.15 7. Specific gravity of aggregate 1. Specific gravity of coarse aggregate= 2.844 2. Specific gravity of fine aggregate= 2.417

Design Calculations – Mix Design by IS 10262: 2009

Step-1 Calculation of Target mean strength fck′ = fck + 1.65s= 30 + (1.65*5)= 38.25 MPa Step-2 Calculation for Quantity of Water For 20mm aggregates = 186litres For 50-75mm slump = 186+ (3/100) × (186) = 191.58liters Step-3 Calculation for weight of cement: Water Cement ratio is taken as 0.45 Cement content = 186/0.45= 413.33 kg/m3 Minimum Cement content = 320 kg/m3 Step-4 Calculation for Volume of Materials W/c ratio = 0.45 (when compared with 0.5, it is nearly less by 0.1). Volume of C.A = 0.62 (For Zone I Volume is 0.6) Volume of F.A = 1-0.6 Volume of C.A = 0.4 Volume of concrete = 1m3 Volume of cement = Mass of cement Specific gracvity of cement × 1 1000 = 456.413 3.15 × 1 1000 = 0.1312 m3 Volume of water = 186 1 × 1 1000 = 0.186 m3 Volume of all aggregates = 1-(0.1313+0.186) = 0.683m3 Step-5 Calculation for weight of Coarse Aggregate and Fine Aggregate Mass of C.A = 0.683 x 0.56 x 2.798 x 1000= 1245.44kg Mass of F.A = 0.683 x 0. 44 x 2.449 x 100= 650.52kg

RESULTS AND DISCUSSION

Compressive Stress Test

All the cubes were tested under drying condition, after drying the surface of the specimens containing no moisture in it.

The compressive strength at the various ages such as 7 and 28 days for water cement ratio 0.45, 10%, 20%, 30%, 40%, 50%, and 60% of copper slag is replaced with the weight of fine aggregate and 0.5% of Glass fiber is kept constant throughout the mix, to find the compressive strength. From the test results, when copper slag and glass fiber was added, it was observed that the compressive strength increases with the replacement percentage of copper slag increases. Also from the test results, it is inferred that replacement percentage of copper slag more than 40% tends to decrease the compressive strength. Thus, the optimum compressive strength was obtained at 40% of copper slag and 0.5% of glass fiber. From the results, it was found that the strength of the respective mix also lowers in early days. But in later days it achieves somewhat higher result compared to the earlier mix.

Compressive Strength Test

Split Tensile Strength

Split tensile strength were carried out at the age of 28 days for the cylinder specimen of size 150mm diameter and 300mm length, using compression testing machine of 2000kN capacity as per IS 516-1959.

$Ft = 2P/\pi DL$

where, Ft – Split tensile strength of concrete in MPa P - Failure load in N D – Diameter of cylinder (150mm) L – Length of cylinder (300mm)

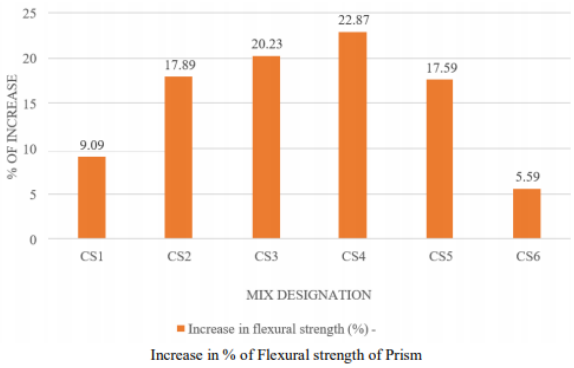
From the test results, it was observed that the maximum split tensile strength was obtained for mix with Replacement of fine aggregate by 40% copper slag and adding 0.5% Glass fibre. The split tensile strength of cylindrical specimens for various replacement percentages of sand with copper slag. The optimum value was obtained at 40% replacement of sand with copper slag. When copper slag had been replaced with Ordinary Portland Cement, the Copper slag admixed concrete showed higher split tensile strength values than corresponding control concrete. The percentage increase in Spilt-tensile strength was found to be 36.434% at 40% replacement of sand that of control concrete. Therefore, it was observed that the addition of copper slag increased the split tensile strength of concrete admixed concrete up to 40% addition in sand.

Split tensile strength of cylinder under test

Flexural Strength

The variations in flexural strength at the age of 28 days with different percentage of FRC were plotted in fig. From the test results, it was observed that when the percentage of copper slag increases, the flexural strength of concrete decreases. It was also observed that the strength of concrete in compression and strength of concrete in flexure are closely related.

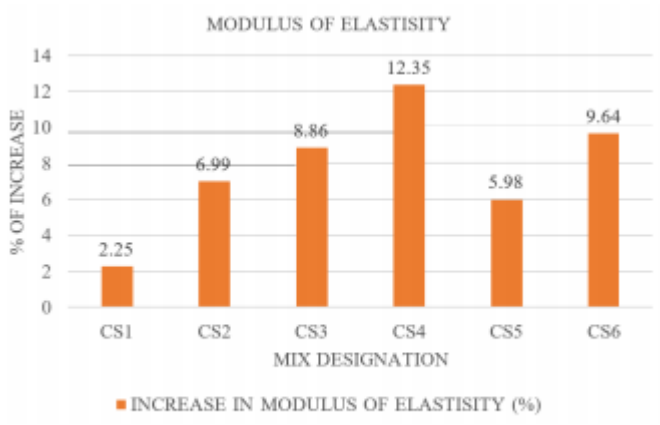
Testing of Flexural Strength of Prism



Modulus of Elasticity

The modulus of Elasticity of cube specimen is calculated according to IS: 456 -2000 by the formula E = 5000 √Fck. It is seen from the test results that modulus of elasticity goes on decreasing as increase in the replacement of natural sand by copper slag. The modulus of Elasticity of reference concrete was 30.06 x

103 N/mm2. The modulus of elasticity for 40% replacement is increased by 12.35% with respect to controlled concrete. The graph 3. 5 shows the variation in modulus of Elasticity for 28 days.



Increase in % of Modulus of Elasticity of Cylinder

Water Absorption Test

The specimens were weighed before drying. The drying was carried out in a hot air oven at the temperature of 105°C. The drying process was agreed closely. The specimen was carried out at regular interval of time, surface dried using a clean cloth and weighed. The difference between the measured water saturated mass and oven dried mass expressed as percentage of oven dried mass gives the WA. The water absorption was calculated as

% of water absorbed = Ws – Wd / Wd × 100

Porosity Test

The porosity test results are tabulated in table. The result of porosity denotes that the percentage of porosity increased with the addition of aluminum dross, silica fume and fly ash.

Acid Resistance Test

But compressive strength of proportioned mix is so much decreased compared to nominal mix.

MIX DESIGNSTION	Average loss of weight (%)	Average loss of compressive strength (%)
CS0	4.65	6.32
CS4	4.94	12.18

CONCLUSION

Strength Aspects:

Experiments were conducted on concrete containing various proportions of Copper slag and Glass fiber. The Copper slag was obtained from Sterlite Industries India Limited (SIIL), Tuticorin, Tamil Nadu, India. The strength characteristics of concrete with different replacement percentage levels of the Copper slag were studied at different ages. On adding copper slag it gives a very good result on compressive strength but it gives a moderate result in durability aspect.

1. Replacement of fine aggregate by 40% copper slag and adding 0.5% Glass fiber gives better result at all ages. 2. The main aim of adding Copper slag is for economy and for improving the strength of hardened concrete. 3. Split tensile strength and Flexural strength is also optimum for the mix comprising by replacement of fine aggregate by 40% copper slag and adding 0.5% Glass fiber 4. Also it is observed that

strength of the concrete increases with up to 40% of copper slag. 5. But on increasing the copper slag content above 40%, there is some reduction in 6. strength. 7. By 40% replacement of copper slag with 0.5% Glass fiber gives Maximum percentage increase in split tensile strength is 36.434% and Maximum percentage increase in modulus of elasticity is 24.987%. 8. Mix proportion of CS4 gives 22.87% increase in Flexural strength of Prism. 9. The CS4 Mix proportion gives more optimum results in Strength results. 10. The beams were cast for optimum percentage (CS4) and flexural strength were carried out. 11. From flexural test on beams, the mix CS4 having higher ultimate load carrying capacity that all mixes. 12. Compare to control mix (CS0), mix CS4 having 12.5% increase in ultimate load carrying capacity.

Durability Aspects:

Experiments were conducted to study water absorption, porosity and acid resistance for nominal mix and for optimum mix consists of Replacement of fine aggregate by 40% copper slag and adding 0.5% Glass fiber of water cement ratio 0.45.The following are the general conclusions arrived from the above studies. 1. The saturated water absorption and porosity of proportioned optimum mix (CS4) containing copper slag and Glass fiber were lower when compared with that of the nominal mix. 2. From acid resistance test, it was observed that the concrete containing copper slag was found to be slightly low resistant to the H2So4 solution than the control concrete. 3. Water absorption and porosity tests shows that increase in copper slag decreases the water absorption and porosity values since the concrete becomes denser due to the addition of copper slag. 4. Since copper slag concrete exhibits good durability characteristics, it can be used as an alternate to fine aggregate. Works can be made on designing and experimentation using codes other than IS codes are suitable. Studies on workability may be made by introducing a super plasticizer could be made. Durability studies such as air-void analysis, chloride diffusion studies, permeability, sulphate attack etc., could be studied in detail.

REFERENCE

1. Akihiko Y, Takashi Y. Study of utilization of copper slag as fine aggregate for concrete. Shikaya Kogyo Daigaku Kenkyu Shuroku1996;23:79_/85. 2. Ayano Toshiki, Kuramoto Osamu, Sakata Kenji , “Concrete with copper slag fine aggregate.” Society of Materials Science, 2000, vol.49, n10, pp.1097•1102. 3. AlJabri K, Taha R, Al Ghassani M. Use of copper slag and cement bypass dust as cementitious materials. Cement concrete aggregates 2002:24(1):pp7•12. 4. Bipra gorai, R.K.Jana, Premchand, “Characteristics and utilisation of copper slag are view”. Resources, Conservation and Recycling 39 (2003) pp299•313. 5. Collins R, Ciesielski SK. Recycling and use of waste material sand by-products in highway construction. In: National cooperative highway research program synthesis of highway practice no.199.Washington (DC): Transportation Research Board ;1994. 6. Mobasher B, Devaguptapu R, Arino AM. Effect of copper slag on the hydration of blended cemetitious mixtures. In: Chong K, editor. Proceedings of the ASCE 7. Collins R, Ciesielski SK. Recycling and use of waste materials and by-products in highway construction. In: National cooperative highway research program synthesis of highway practice no.199. Washington (DC): Transportation Research Board;1994. 7. Moura W, Masuero A, DalMolin D, Vilela A. Concrete performance with admixtures of electrical steel slag and copper concerning mechanical properties. ACI SP•186; 1999.pp.81–100. 8. Teik Thye Lim, J.Chu, “Assessment of the use of spent copper slag for land reclamation”.WasteManageRes2006:24:pp67–73. 9. Tobisaka Motoo, Oshima Akira, “Co lours of Concrete Using Copper Slag Fine Aggregate.”ISSN:0289•6026VOL.35;NO.6;PAGE.11•13(1999). 10. Caijun Shi, Jueshi Qian, “High performance cementing materials from industrial slags are view”Resources, Conservation and Recycling29(2000)pp195–207.